Chapter 3
Conservation Strategy (Sections 3.1 and 3.2)

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Acronyms and Abbreviations

BDCP	Bay-Delta Conservation Plan
BiOp	biological opinions
CALFED	California Bay-Delta Authority
CESA	California Endangered Species Act
CVP	Central Valley Project
DFG	California Department of Fish and Game
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
ESA	Endangered Species Act
GIS	geographic information system
HCP	habitat conservation plans
NCCP	natural community conservation plan
NCCPA	Natural Community Conservation Planning Act
NMFS	National Marine Fisheries Service
ROA	Restoration Opportunity Areas
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service

Chapter 3
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3.1 Introduction

*[**Note to Reviewers:** Section 3.1, this introduction, describes the conservation strategy, provides an overview of its principal elements, and describe relevant policy, regulatory, and legal points. Chapter 3 also provides much of the project detail that supports Chapter 4, Covered Activities and Associated Federal Actions.]*

This chapter sets out the Bay-Delta Conservation Plan (BDCP or Plan) conservation strategy, which consists of multiple components that are designed collectively to achieve the overall BDCP goal, which is to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework. The chapter describes the Plan's intended biological outcomes and details the means by which these outcomes will be achieved. The conservation strategy includes the BDCP's biological goals and objectives and identifies a set of conservation actions to provide for the conservation and management of covered species and natural communities upon which they depend, and to avoid, minimize, and mitigate for the potential effects of covered activities on these resources (Chapter 4, *Covered Activities and Associated Federal Actions*). The conservation strategy also includes comprehensive programs for monitoring, research, and adaptive management. The conservation strategy has been developed to meet the regulatory standards of Sections 7 and 10 of the federal Endangered Species Act (ESA), the Natural Community Conservation Planning Act (NCCPA), and, as appropriate, the California Endangered Species Act (CESA).

The conservation strategy reflects a comprehensive suite of measures that will address the obligation to offset take associated with the covered activities, and additional measures that will not be the obligation of the permittees, but have been included to further the conservation and recovery of the Delta ecosystems and covered species. Thus, the conservation strategy represents a comprehensive suite of actions that has been developed to offset the effects of all of the BDCP covered activities, as well as other actions intended to improve the ecological conditions in the Plan Area for covered species.

The conservation strategy addresses the challenge of restoring key ecosystem functions in the highly altered environment of the Delta while restoring water supplies and the reliability of delivery of those supplies. The Delta was once a vast marsh and floodplain intersected by meandering channels and sloughs that provided habitat for a rich diversity of fish, wildlife, and plants. The Delta of today is a system of artificially channeled and dredged waterways constructed into static geometries designed initially to support farming, and later, urban development. These channels also serve to convey water supplies across the Delta for export to cities and farms in the San Francisco Bay Area, San Joaquin Valley, and southern California. Physical disturbances within the Delta, the introduction of nonnative species that have disrupted the foodweb, and multiple other environmental challenges to the ecosystem have contributed to declines in native fish, wildlife, plant species, and other organisms. In recent years, these factors have contributed to a significant drop in the population structure of key native species.

The approach embodied in the BDCP and its conservation strategy reflects a significant departure from the manner in which at-risk Delta species and natural communities have been managed in the

past. The BDCP will contribute to the restoration of the health of the Delta's ecological systems by addressing ecological functions and processes at a broad landscape scale, as well as by focusing on discrete components. Unlike past regulatory approaches that have relied almost exclusively on iterative adjustments to the operations of the State Water Project (SWP) and the Central Valley Project (CVP), including those reflected in recent biological opinions (BiOps) issued by the U.S. Fish and Wildlife Service (USFWS) (2008) and the National Marine Fisheries Service (NMFS) (2004, 2009), the BDCP proposes fundamental, systemic, long-term physical changes to the Delta, including substantial alterations to water conveyance infrastructure and water management regimes, extensive restoration of habitat features, as well as measures specifically designed to offset ecological stressors. These ecosystem-wide changes are intended to enhance ecological productivity (structure and function) as well as advance the conservation of species and the natural communities that depend upon them.

The BDCP Plan Area includes the statutory Sacramento-San Joaquin Delta, as defined in California Water Code Section 12220; Suisun Marsh; and the Yolo Bypass (Section 1.4.1, *Geographic Scope of the Plan Area*). Because the state and federal water infrastructure operates as an integrated system, effects of the BDCP will extend both upstream and downstream of the Plan Area, and will implicate both water operational parameters and covered fish species and their habitats. Therefore, the BDCP will take into account these upstream and downstream effects, both positive and negative, to ensure that the overall effects of the BDCP are fully analyzed and understood (Section 3.6, *Adaptive Management and Monitoring Program*).

While the initial focus of the BDCP was to address the conservation of Delta fish species that are currently at very low population levels, such as delta smelt, longfin smelt, winter-run Chinook salmon, spring-run Chinook salmon, and green sturgeon, the conservation strategy evolved to include measures to address a broad range of species and natural communities. The conservation strategy provides for the conservation and management of 60 species, including 11 fish species, 30 wildlife species, and 10 plant species (Section 1.4.3, *Covered Species*), as well as 13 natural communities (Section 1.4.2, *Natural Communities*). The conservation strategy sets forth actions that reduce the effects of environmental stressors on these biological resources at various ecological scales, including landscape-scale actions to address physical and chemical processes and food webs; natural community actions that address the ecological functions and processes of specific natural communities that contribute to the overall ecological health, and species-specific actions that address population size and structure as well as the distribution of individual covered species.

The conservation strategy is built upon and reflects the extensive body of scientific investigation, study, and analysis of the Delta compiled over several decades (CALFED Bay-Delta Program 2008). For example, the BDCP draws on the results and findings of numerous studies initiated under the California Bay-Delta Authority (CALFED) Bay-Delta Science Program (now the Delta Science Program) and Ecosystem Restoration Program, the long-term monitoring programs conducted by the Interagency Ecological Program, research and monitoring conducted by state and federal resource agencies, and research contributions of academic investigators.

The development of the BDCP has also been informed by a number of other recent reports on the Delta, including reports of the Governor's Delta Vision Blue Ribbon Task Force (January and October 2008), reports from the Public Policy Institute of California (Lund et al. 2007, 2008), and reviews by the National Research Council (National Research Council of National Academies 2011). Many elements of the conservation strategy parallel the recommendations of these other reports and

reflect broad agreement that the Delta is dysfunctional from both an ecological and water supply reliability perspective and that fundamental change is necessary.

To ensure that the BDCP would be based on the best information available, the Plan participants engaged in a rigorous process to develop new and updated information and to evaluate a wide variety of issues and approaches as it formulated a cohesive, comprehensive conservation strategy. This effort included a 2009 evaluation of BDCP conservation options using the modified version of the CALFED Bay–Delta Ecosystem Restoration Program's Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) evaluation process (Essex Partnership 2009). Reflecting the requirements of the NCCPA planning process, the Steering Committee also sought and used independent scientific advice at several key stages of the planning process, enlisting well-recognized experts in ecological and biological sciences to produce recommendations on a range of relevant topics, including approaches to conservation planning for both aquatic and terrestrial species, establishing an adaptive management and monitoring program, and devising biological goals and objectives. These processes are summarized in Chapter 10, *Integration of Independent Science in BDCP Development*. The following sections introduce the conservation strategy in more detail. Section 3.1.1, *Biological Goals and Objectives*, describes the biological goals and objectives of the Plan. Section 3.1.2, *Conservation Measures*, identifies the specific conservation measures that will be implemented to achieve those biological goals and objectives. Section 3.1.3, *Adaptive Management and Monitoring Program*, describes the biological monitoring, research, and adaptive management program.

3.1.1 Biological Goals and Objectives

The BDCP biological goals and objectives reflect the expected ecological outcomes of the Plan, and set out the broad principles that were used to help guide the development of the conservation strategy. Biological goals and objectives are the foundation of the conservation strategy and are intended to provide the following functions.

- Describe the desired biological outcomes of the conservation strategy and how those outcomes will contribute to the long-term conservation of covered species and their habitats.
- Provide, when possible, quantitative targets and timeframes for achieving the desired outcomes.
- Serve as yardsticks by which to measure progress in achieving those outcomes across multiple temporal and spatial scales.
- Provide metrics for the monitoring program by which to evaluate the effectiveness of the conservation measures and, if necessary, provide a basis to adjust the conservation measures to achieve the desired outcomes.

The biological goals and objectives are organized hierarchically on the basis of the following ecological scale.

- **Landscape-scale biological goals and objectives.** These goals and objectives focus on the extent, distribution, and connectivity among natural communities and improvements to the overall condition of hydrological, physical, chemical, and biological processes in the Plan Area in support of achieving natural community and species-specific goal and objectives.
- **Natural community biological goals and objectives.** These goals and objectives focus on maintaining or enhancing ecological functions and values of specific natural communities.

Achieving natural community goals and objectives will also conserve the habitat of associated covered species and other native species.

- **Species biological goals and objectives.** These goals and objectives address species-specific stressors and habitat needs that are not addressed under the higher-order landscape and natural community goals and objectives.

These goals and objectives describe the desired future conditions of the Plan Area and set the benchmarks for evaluating BDCP performance relative to ecological health. They are intended to be attainable and directly relevant to the BDCP conservation measures, and define qualities of an ecologically healthy Delta. The biological goals and objectives reflect the relationship between environmental change and species response. Section 3.3, *Biological Goals and Objectives*, describes the framework and the process used to develop the BDCP biological goals and objectives at the landscape scale, for natural communities, and for covered species.

3.1.2 Conservation Measures

The conservation strategy uses a multi-scale approach in accordance with the principles of conservation biology. As mentioned above, biological goals and objectives are organized hierarchically at a scale that accounts for landscape-scale, natural community, and species-specific goals and objectives, to encompass ecological processes, environmental gradients, biological diversity, and regional aquatic and terrestrial linkages.

The BDCP conservation measures comprise specific actions that will be implemented to achieve the biological goals and objectives of the Plan. The conservation measures fit into the same ecological hierarchy as the biological goals and objectives.

- **Landscape-scale conservation measures.** Landscape-scale conservation measures are designed to improve the overall condition of hydrological, physical, chemical, and biological processes in the Plan Area. These measures include improving the method, timing, and amount of flow and quality of water into and through the Delta for the benefit of covered species and covered natural communities. They also focus on establishing an interconnected system of conservation lands across the Plan Area.
- **Natural community conservation measures.** Natural community conservation measures include actions to restore natural communities to expand the extent and quality of intertidal, floodplain, and other ecological functions and processes.
- **Species-specific conservation measures.** Species-specific conservation measures are designed to reduce the adverse effects of various stressors on one or more covered species. These include measures addressing toxic contaminants, nonnative predators, illegal harvest, and genetic threats.

This comprehensive suite of actions is expected to make a substantial contribution to the conservation of covered species and natural communities and the restoration of ecosystem health in the Delta, while providing for a reliable water supply for human use.

The conservation measures were developed in the context of the 50-year timeframe for implementation of the BDCP. Section 3.2, *Methods and Approaches Used to Develop the Conservation Strategy*, describes how the conservation measures were developed. Section 3.4, *Conservation Measures*, describes each of the 22 proposed conservation measures in detail.

3.1.3 Adaptive Management and Monitoring Program

3.1.3.1 Adaptive Management

The adaptive management program described in detail in Section 3.6, *Adaptive Management and Monitoring Program*, is central to the success of the Plan. It includes a combination of system-wide and conservation measure-specific monitoring and research processes, which will integrate new data, knowledge, and scientific information to enhance the efficiency and efficacy of the BDCP conservation measures. The adaptive management program will provide the mechanism by which conservation measures can be modified or discontinued in response to results from BDCP monitoring and research programs and other new scientific information.

Adaptive management is an organizational process that requires the description of carefully designed management actions (e.g., conservation measures), assessment of the effects of those actions (e.g., monitoring and research), and subsequent adjustment (e.g., resource management decisions). The concept of adaptive management has gained worldwide interest and support as an approach to sustainable ecosystem management. Lindenmayer and Burgman (2005) suggest that an adaptive management program should include these key elements.

- Explicit definition of management goals.
- Development of plausible strategies to achieve those goals.
- Implementation of strategies in a comparative experimental framework to spread risks of management failure and improve understanding of system responses to management.
- Monitoring to evaluate the relative merits and limitations of management strategies.
- Iterative modification of management strategies to improve outcomes.

Within the context of the BDCP, a number of key factors will influence a resource management decision. These factors are associated with both the expected certainty associated with the outcome and the scientific and/or policy drivers associated with taking a resource management action.

If monitoring data or other scientific information suggests that progress toward the biological goals and objectives is not being made, decisions will be made regarding whether and how to refine the monitoring program, conservation measures, conceptual models (including hypotheses on which the models are based), biological objectives, or a combination of these outcomes.

3.1.3.2 Monitoring

The BDCP monitoring program, described in Section 3.6, *Adaptive Management and Monitoring Program,* is designed to answer the following questions.

- Are actions being implemented on the proposed schedule?
- Is habitat for covered species changing as expected (e.g., primary and secondary productivity is increasing, connectivity is increasing, and water quality is improving)?
- Are covered species responding to habitat changes as expected (e.g., growth is increasing, abundance is increasing, populations are expanding)?

Monitoring of indices and metrics appropriate to these questions provides the first level of adaptive management, and can also provide relatively rapid feedback on BDCP implementation. In general, monitoring will include two components.

- **Compliance monitoring:** Compiles information on how well the Authorized Entities are meeting statutory requirements of the BDCP.
- **Effectiveness monitoring**: Compiles information on how well the conservation measures meet intended objectives.

3.1.3.3 Uncertainty and Directed Research

The ecological systems associated with the BDCP Plan Area are inherently complex and often subject to high levels of uncertainty. Complexity arises from the numerous biological, physical, chemical, and social interactions within these ecosystems. Uncertainty over the life of the BDCP comes from several sources, including the following.

- Natural variability in environmental conditions caused by local, regional, and global factors.
- Change in environmental conditions (e.g., climate change).
- Limitations in scientific knowledge regarding key factors and pathways.
- Foreseeable and unforeseen and rare events (e.g., earthquakes).

The adaptive management approach addresses uncertainty through a structured process that provides for the improvement of relevant knowledge, while seeking to minimize risks associated with implementing proposed activities. Detailed discussions of the uncertainty and research components to the BDCP adaptive management approach are provided in Section 3.6, *Adaptive Management and Monitoring Program*.

3.2 Methods and Approaches Used to Develop the Conservation Strategy

This section describes the methods and the approaches used to develop the BDCP conservation strategy. Section 3.2.1, *Framework for the Conservation Strategy*, describes the regulatory and temporal contexts for the conservation strategy. It also describes the role of the adaptive management and monitoring program in reinforcing the effectiveness of the conservation strategy over time. The conservation strategy addresses both aquatic resources, encompassing the aquatic ecosystem and the covered fish species, and terrestrial resources, encompassing nontidal natural communities and covered wildlife and plant species. This approach to developing the aquatic resources component of the conservation strategy is described in Section 3.2.3, *Developing the Aquatic Resources Component of the Conservation Strategy*.

The terrestrial resources conservation strategy was guided by an established process used in other habitat conservation plans (HCPs)/natural community conservation plans (NCCPs) and USFWS recovery plans that address many of the same species and communities. This approach to the development of the terrestrial resources component is described in Section 3.2.4, *Developing the Terrestrial Resources Component of the Conservation Strategy*.

While these approaches are described separately, the two are interrelated and together are reflected in the overall BDCP conservation strategy. Background on the planning process for the major elements of the conservation strategy is provided in Appendix 3.A, *Background on the Process of Developing the BDCP Conservation Measures.*

3.2.1 Framework for the Conservation Strategy

The conservation strategy is designed to meet the regulatory requirements of the ESA and the NCCPA, while achieving the overall BDCP goal to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework. Consistent with the requirements of the ESA and NCCPA, the conservation strategy provides for the conservation and management of covered species through the creation, protection, restoration, and enhancement of ecosystem processes, natural communities, and species habitat.

Biological goals and objectives were first developed at the landscape scale to account for ecological processes that could be addressed by BDCP. Next, goals and objectives were developed at the natural community level to address discrete habitat functions at a more manageable scale, such as tidal restoration, nontidal emergent wetland, and valley/foothill riparian natural communities. Finally, goals and objectives were developed at the species level to provide specific metrics for the conservation and/or recovery of the covered species. For fish, the species-specific goals and objectives were linked to broader global goals developed by the resource agencies that are intended to achieve recovery of species. While BDCP species-specific goals and objectives will contribute toward achieving the broader global goals and objectives, they will not in and of themselves achieve the global goals and objectives. Finally, conservation measures have been drafted, which are the measures that will be implemented as part of BDCP to achieve the landscape, natural community and species goals and objectives. In developing the conservation strategy, each covered species was evaluated to determine whether achieving the landscape-scale or natural community goals and objectives would completely meet the needs of the species. If not, species-specific goals and objectives were developed to ensure BDCP contributed to the conservation and/or recovery of each covered species. Conservation measures were developed to meet landscape-scale, natural community, and species-specific goals and objectives. The conservation strategy includes several types of conservation measures, described below.

- Measures that provide for the development and operation of new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities.
- Habitat protection measures that protect existing functioning natural communities that are not currently protected.
- Habitat restoration/creation measures that restore specific natural communities in areas that do not currently support those communities.
- Habitat enhancement measures that improve existing habitat functions within existing natural communities.
- Habitat management measures that provide for ongoing management of natural communities and habitat to maximize the functional values of BDCP conservation areas over the long term.

- Measures to address other stressors that reduce the adverse effects on covered fish species that result from specific stressors such as predation, toxic constituents in water, or sediment, and illegal harvest.
- Avoidance and minimization measures that ensure that adverse effects of covered activities on covered species are avoided or minimized to the maximum extent practicable.

All conservation measures have been developed at a sufficient level of detail and specificity to ensure their implementation. Because the BDCP is broad in scope and has an extended timeframe for implementation, many of the measures have the flexibility needed to accommodate changes in conditions and methods over time. For example, natural community–scale actions provide management guidelines and principles that provide land managers the freedom to implement techniques best suited to site conditions. Preserving this flexibility is an important part of the conservation strategy and is articulated in Section 3.6, *Adaptive Management and Monitoring Program*.

Implementation of habitat protection, enhancement, and restoration conservation measures will require preparation of site-specific implementation documents. These implementation documents, as well as any additional environmental documentation, will be prepared in accordance with the schedule for the implementation of conservation measures (Chapter 6, *Plan Implementation*).

3.2.1.1 The Importance of Adaptive Management, Monitoring, and Research

Adaptive management, monitoring, and research will play an important role in BDCP implementation because of the inherently dynamic nature of the Delta ecosystems, the expected changes in these dynamics over time (e.g., effects of climate change on sea level and watershed hydrology), and uncertainties related to the likely response of certain covered species to certain conservation measures.

The Delta is likely to change over the course of plan implementation in response to climate change, seismic events, changes in land use, and other factors. Adaptive management, monitoring, and research provide the means to incorporate new information and insight regarding observed or projected changes into plan implementation. As better understanding of the Delta ecosystem is acquired, conservation measures might be refined accordingly, in order to enhance their effectiveness. Refer to Section 3.6, *Adaptive Management and Monitoring Program*, for details.

3.2.1.2 The Timing and Interrelatedness of Conservation Measures

The conservation strategy is divided into near-term and long-term implementation stages. The near-term implementation lasts until the north Delta diversion and tunnel/pipeline conveyance facilities are constructed and operational, anticipated to occur within a 15-year period. Long-term implementation lasts 35 years, through the remainder of the 50-year BDCP permit term. This division of the implementation period was used because dual conveyance from north and south Delta intakes will bring significant flexibility and ecological changes to the system. As a result, many of the conservation measures are interrelated with operations of the new conveyance.

Near-term implementation of conservation measures will provide a rapid response to currently degraded or absent ecological functions, while building the foundation to improve long-term

ecological functions. The near-term measures include early habitat creation or restoration actions, implementation of conservation measures that address other stressors on covered fish species, and acquisition of terrestrial and wetland habitat to provide conservation for covered wildlife and plant species.

Completion and operation of the north Delta intakes and conveyance facility will facilitate implementation of conservation measures restoring tidal and floodplain habitat in the east and south Delta associated with the Mokelumne, Cosumnes, Middle, Old, and San Joaquin Rivers. Changes in water operations in any one part of the Delta affect flow in other parts of the Delta, and these relationships must be addressed. For example, diversions in the north Delta reduce the need to export at the south Delta diversions, thereby reducing reverse flows in Old and Middle Rivers. The coordinated operations of new and existing water facilities in a flexible and adaptable manner is a necessary step towards meeting the overall BDCP goal, which is to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework.

Restoring large portions of the Delta to tidal habitat will affect hydrodynamics and water quality by enlarging the tidal prism (the volume of water in an estuary as calculated by the volume between mean high tide and mean low tide) and reducing the tidal range. For example, restoration of tidal habitats in the Cache Slough area is projected to result in reduced tidal range and greater unidirectional flows in Sutter and Steamboat Sloughs, speeding the passage of juvenile salmonids migrating through these sloughs and thereby reducing their exposure to predation. The reduction in pesticide and herbicide loads that will result from restoring habitat on agricultural lands is expected to interact synergistically with improvements in organic and nutrient input from restored tidal marsh and floodplains to benefit the aquatic food web. These examples show how substantial benefits of the conservation strategy derive from understanding interconnections amongst conservation measures across program elements, across the wide geography of the Delta, and across time. In short, the conservation strategy is intended to be more than the sum of its parts.

Although the conservation measures have been developed to benefit the covered species, the measures will not necessarily benefit the species equally, and in some cases may have adverse effects. For example, providing flows for the migration of one species may have unintended direct or indirect consequences on another species due to changes in rearing habitat characteristics for that species. Such interrelated adverse effects will be assessed in the adaptive management process, and modifications made to the conservation measures, as required.

The Implementation Office will time and sequence the acquisition and restoration of conservation lands to protect and restore habitats, ensuring that conservation actions occur in a manner that is roughly proportional to and commensurate with the effects of covered activities. See Chapter 6, *Plan Implementation*, for a discussion of the implementation schedule for each conservation measure.

3.2.1.3 Functional Relationship of Conservation Strategy Components

The process of developing the BDCP conservation strategy was complicated by the challenges associated with ecological requirements that vary among the covered species, the physical complexity of the Delta, and uncertainties about process and function in these ecosystems. As part of this process, the linkages between key plan elements were identified in order to help organize and address the elements of this complex system. Biological goals and objectives for the covered fish species were also identified during this process.

BDCP goals and objectives were also informed by global goals and objectives (as provided by the resource agencies), but were framed to reflect what is achievable within the context of BDCP. This approach explicitly focused on select stressors that the BDCP would address, and outlined the scientific understanding behind why the conservation strategy (and associated conservation measures) were expected to achieve the goals and objectives. Understanding these key linkages helped to facilitate the evaluation of the Plan components and their likely effectiveness as they are implemented over time. As a result, the conservation strategy uses a comprehensive approach that accounts for the relationships between what the BDCP is trying to accomplish and how it intends to achieve its objectives (Figure 3.2-1) and the subsequent description of the various elements. While the goals and objectives of the BDCP are compatible with these broader global goals and objectives, and support the achievement of their desired outcomes, some of the outcomes are beyond the scope of the BDCP.

The narrative below describes the various elements outlined in Figure 3.2-1. The numbers in the narrative correlate to the numbers in Figure 3.2-1.

1. At the top of triangle are the global goals and objectives that were developed for the conservation and recovery of each of the covered species. The global goals and objectives were developed independent of the BDCP and are intended to guide recovery efforts for the covered species. BDCP will contribute to recovery; thus, there is a clear link to the needs of those species. This is best defined by existing recovery plans for each species. If a recovery plan is not available, the responsible agencies provided guidance on appropriate goals and objectives for the species as a whole.

2. The contribution to recovery made by the BDCP is not predefined. Expert opinion and conceptual models of the covered species were used to identify limiting factors/stressors for the species; the BDCP further selected those limiting factors/stressors that could be addressed by the Plan and that occur within the Plan Area. From this subset of limiting factors, the BDCP identified more specific goals and objectives that are within its scope and that are scaled by the level of effort envisioned for the Plan.

   The Plan's contribution to recovery was also guided by the proportion of a species' range and life cycle within the Plan Area and the level of effect on that species. For example, all else being equal, the Plan's obligation to contribute to recovery for a species with a small portion of its range in the Plan Area is less than the Plan's obligation to contribute to recovery for a species with a large portion of its range in the Plan Area.

3. Conservation measures were developed to achieve the BDCP goals and objectives, based on simple models (e.g., conceptual, statistical) to assess potential outcomes. Conservation measures are also intended to contribute toward achieving the global goals and objectives.

4. Once the conservation measures were identified, they were developed in greater detail and more specific expected outcomes identified. Available models were used to test whether conservation measures, collectively, would achieve BDCP goals and objectives. Where results are weak or there is high uncertainty in the outcome, testable hypotheses were developed to link the action to the outcome (Chapter 5, *Effects Analysis*), and directed research projects were identified to test the hypotheses, monitor trends, and to fill data gaps and uncertainties in our understand of the covered species and their expected reaction to changes in their environment (Section 3.6, *Adaptive Management and Monitoring Program*). These hypotheses will be tested in Plan implementation.

5. Monitoring informs all of these steps. System-level monitoring informs whether BDCP goals and objectives are being achieved based on trends. Compliance monitoring ensures that conservation measures are being implemented as intended. Performance monitoring is used to tell whether a conservation measure is achieving the expected outcomes, and mechanistic monitoring provides diagnostic information on why the expected outcomes are or are not being achieved and will contribute toward increasing our understanding of the complexity of the Delta ecosystem and species response to conservation measures. These types of monitoring are described in Section 3.6, *Adaptive Management and Monitoring Program*.

6. Once conservation measures have been implemented and monitoring data are available, adaptive management will inform appropriate changes, either to BDCP goals and objectives or to conservation measures, to achieve the intended outcomes of the BDCP. Adaptive management will be used to assess performance, inform adjustments to implemented projects and future actions, incorporate information as part of the knowledge base, and inform the planning process (Dahm et al. 2010).

3.2.2 Identifying Conservation Zones and Restoration Opportunity Areas

To facilitate development of habitat protection and restoration elements of the conservation strategy, the Plan Area was subdivided into 11 conservation zones within which conservation targets for natural communities and covered species' habitats were established (Figure 3.2-2).

Conservation zones were delineated primarily on the basis of landscape characteristics and logical geographic or landform divisions to create a structured approach to how and where conservation actions will be carried out within the Plan Area. Conservation zones were used as a planning tool to ensure that targets identified for natural communities and covered species habitat will be spatially distributed to achieve biological goals and objectives.

Conservation zones were established using the follow criteria.

- Distribution of covered species within and adjacent to the Plan Area.
- Distribution of natural communities supporting covered species habitats.
- Differences in the function of covered species habitats supported by natural communities in different portions of the Plan Area (e.g., high, medium, and low function as habitat for covered species).
- Landscape features (e.g., watercourses).
- Locations of barriers to covered species movement among habitats.
- Connectivity with existing habitat areas adjacent to the Plan Area.

A different set of planning units, Restoration Opportunity Areas (ROAs), was also established to assist in the development of the conservation strategy. ROAs are different from, but overlap with, the conservation zones, as illustrated in Figure 3.2-2. ROAs encompass those locations considered to be the most appropriate for the restoration of tidal habitats within the Plan Area and within which restoration goals for tidal and associated upland natural communities will be achieved (*CM4 Tidal Natural Communities Restoration*).

The extent of each natural community and of the covered species habitat in each of the 11 conservation zones is presented in Appendix 3.D, *Natural Community and Covered Species Habitat Existing Condition*. The existing distribution of natural communities within each of the conservation zones is presented in Figure 3.2-3 through Figure 3.2-12.

3.2.3 Developing the Aquatic Resources Component of the Conservation Strategy

The aquatic component of the conservation strategy is designed to support restoration of ecological productivity of the Delta and adjacent areas in order to contribute to the conservation of covered fish species and the aquatic natural communities upon which covered fish species depend, consistent with the overall BDCP goal, which is to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework. During the development of the aquatic component of the BDCP, the following key principles were identified.

- **Changes in the estuarine ecosystem may be irreversible.** Human land use has become a major driver of the Bay-Delta ecosystem. Human activities have fundamentally altered the physical, biological, and chemical structure of the Delta and introduced numerous new species that now compete with and prey on native species (Baxter et al. 2010). These changes have produced a Delta ecosystem that is different from the historic ecosystem and will remain so even as anthropogenic stressors are modified as a result of the BDCP. BDCP actions take place in the context of natural and cultural elements that differ markedly from predevelopment conditions.
- **Future states of the Delta ecosystem depend on both foreseeable changes (e.g., climate change and associated sea level rise) and unforeseen or rare events (e.g., the consequences of new species invasions).** The Delta ecosystem is and will continue to be highly variable and will change in both predictable and unpredictable ways. Recovery of covered species in the Delta will require active and adaptive management that reflects new information, different circumstances, and environmental change.
- **The Delta is part of a larger river-estuarine system that is affected by both rivers and tides. The Delta is also influenced by long-distance connections, extending from the headwaters of the Sacramento and San Joaquin Rivers into the Pacific Ocean.** The effects of BDCP actions will reflect the environmental context in which they occur, which includes the Central Valley, San Francisco Bay, and Pacific Ocean.
- **The Delta is characterized by substantial spatial and temporal variability, including disturbances and extreme events that are fundamental characteristics of ecosystem dynamics.** Conditions in the Delta are inherently variable and future conditions are uncertain. Scientific knowledge is limited. Future social and economic factors affecting human land use are uncertain and likely to vary. In short, uncertainty is an inherent feature of the Delta that must be accommodated in an effective management structure.
- **Species that use the Delta have evolved life-history strategies in response to variable environmental processes. A number of covered species have limited ability to adapt to rapid changes caused by human activities.** While estuarine species are adapted to highly variable conditions, the fundamental changes to the Delta ecosystem as a result of human activities may be beyond the adaptive potential of native species.

- **Achieving desired ecosystem outcomes will require more than manipulation of a single ecological stressor.** The physical and biological complexities of the Delta ecosystem argue against simplistic single-factor solutions. Restoration of ecosystem health will require more holistic approaches (Baxter et al. 2010).

- **Habitat should be defined from the perspective of a given species.** Habitat is a species-based concept reflecting the physiological and life-history requirements of species. Habitat is not synonymous with vegetation type, land (water) cover type, or land (water) use type. To succeed, species require sufficient diversity, quantity, and quality of habitat to complete their life histories (Williams 2006).

- **Changes in water quality have important direct and indirect effects throughout the estuarine ecosystem.** Water quality in the Delta is affected by a variety of discharges from agricultural, industrial, and urban sources that have been linked to ecological changes (e.g.,Thompson et al. 2000; Glibert 2010). The Delta environment is characterized by distinct salinity gradients that vary with managed and natural outflow and tides. Water in the Delta is typically turbid, although dams, submerged aquatic vegetation, and other factors have reduced turbidity. Some or all of these conditions may adversely affect performance of native species.

- **Land use is a key determinant of the spatial distribution and temporal dynamics of flow and contaminants, which, in turn, can affect habitat quality.** The BDCP Plan Area is a natural-cultural system with a mix of natural and human-caused features and constraints. Human actions, including the covered activities, may control and alter conditions and could affect species performance.

- **Changes in one part of the Delta may have far-reaching effects in space and time.** The Delta is a system of interconnected biological and physical processes operating across multiple scales. BDCP covered activities and conservation measures are part of an integrated plan. Actions should not be considered in isolation but rather in the context of the Delta ecosystem.

- **Prevention of undesirable ecological responses is more effective than attempting to reverse undesirable responses after they have occurred.** The BDCP would significantly alter the Delta environment and SWP/CVP operations. In some cases, BDCP actions address conditions resulting from the past, for example breaching of dikes to expand wetland habitats. However, the sum of action in the BDCP will create a healthier Delta ecosystem that is better able to accommodate future changes in climate and other factors.

- **Adaptive management is a key component of the BDCP**. Many of these principles point to the highly variable and unpredictable nature of natural systems and the Delta in particular. Fixed management programs may fail as the system shifts and new stressors emerge. Effective management must be adaptive, accepting uncertainty as an inherent condition. An adaptive approach would require explicit management and scientific designs to implement actions.

- **Conservation measures to benefit one species may have negative effects on other species.** Species are connected through the foodweb and through use of common resources. Efforts to enhance one species or a collection of species may have consequences for other species.

Modifying the water conveyance infrastructure to allow for both north and south Delta diversions is essential to creating new opportunities to restore the ecological health of the Delta and to achieve improvements in water supply reliability. The BDCP allows dual operation of the north and south Delta intakes, which provides the operational flexibility to achieve the following improvements.

- Improve passage of fish within and through the Delta by improving hydrodynamic and water quality conditions that can create barriers to movement.
- Allow for restoration of tidal habitats in the east and south Delta by reducing the risk for entrainment of food produced in restored habitat and life stages of covered fish species using this habitat.
- Reduce the risk of entrainment of covered fish species by conveying water from either the north or south Delta, depending on the seasonal distribution of their sensitive life stages.

The conservation strategy for aquatic resources identifies conservation measures that can effectively reverse or reduce the adverse effects of environmental stressors associated with the current water operation regimes on the aquatic ecosystem, covered fish species, and other native aquatic organisms. In addition to the water facilities and operations, the conservation strategy provides for habitat restoration actions to improve rearing, spawning, and migration habitat conditions for the covered fish species and to improve aquatic foodweb processes and actions to address specific stressors on the covered fish species; such stressors include impediments to fish passage, sources of unnatural mortality, and the adverse effects on the genetic integrity of covered fish species.

To improve habitat and foodweb conditions for the covered fish species, the BDCP will restore over 80,000 acres of natural communities, including tidal habitats, seasonally inundated floodplains, and adjacent transition uplands; 20 miles of channel margin habitat; and enhancement of seasonally inundated floodplain habitats of the Yolo Bypass through operation of a modified Fremont Weir. These restored natural communities will substantially increase the extent and quality of physical habitat available for covered fish species.

The ROAs described in Section 3.2.2, *Identifying Conservation Zones and Restoration Opportunity Areas* (Figure 3.2-2), were selected specifically to encompass areas most suitable for the restoration of tidal habitats and the most beneficial locations for covered fish species that use main channels, distributaries, and sloughs of the Sacramento, San Joaquin, and Mokelumne Rivers and the channels and sloughs of Suisun Marsh. Prior to completion of the new conveyance facility, tidal natural communityrestoration actions will focus on the Cache Slough and Suisun Marsh ROAs, which are less affected by current through-Delta conveyance operations. Expansion of tidal habitat in these ROAs will benefit delta smelt and longfin smelt. The expansion of tidal area will affect flows in the Sacramento River and its distributaries to the benefit of Sacramento River salmonids. Constructing the new north Delta diversions and isolated tunnel/pipeline facility will open up significant additional tidal habitat restoration opportunities that do not currently exist. Accordingly, the long-term phase of the physical habitat restoration program will emphasize restoration of tidal and floodplain habitats in the northeast and south Delta to benefit San Joaquin, Mokelumne, and Cosumnes River salmonids as well as sturgeon, splittail, and lamprey. As described in Section 3.2.4, *Developing the Terrestrial Resources Component of the Conservation Strategy*, these restoration actions will also benefit covered wildlife and plant species that use tidal marsh and riparian habitats.

The aquatic strategy also includes conservation measures to reduce the direct and indirect adverse effects of other stressors on the ecological functions of the Delta and the covered fish species. These conservation measures offer opportunities to reduce adverse effects on the covered species, and otherwise improve the health and productivity of the covered species. These other stressors include, but are not limited to, poor water quality (e.g., low dissolved oxygen and contaminants), predation

and competition by nonnative species, illegal harvest activities, and the genetic effects of hatchery-raised fish. Implementation of conservation measures addressing these other stressors is expected to reduce adverse effects on covered species health and productivity.

3.2.3.1 Water Facilities and Operations

The BDCP conservation strategy includes conservation measures that provide for the development and operation of new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities. Central to the conservation strategy is the development and operation of new north Delta intake facilities that will be located along the Sacramento River and will divert water to the south Delta through an isolated tunnel/pipeline. The combination of moving water through a new isolated tunnel/pipeline facility in conjunction with the existing south Delta facilities (referred to as dual operations) is expected to provide flexibility sufficient to substantially improve conditions for covered fish species as well as restore the water supply. The operation of these dual facilities as set out in the BDCP is expected to benefit different species at different times, under a variety of conditions. Dual operation of new and existing diversion facilities is expected to reduce levels of entrainment of native fish at the south Delta SWP/CVP facilities, particularly delta and longfin smelt. Despite these expected overall benefits, the operation of a new facility could have some indirect, inadvertent, or unforeseen adverse effects on some of the covered fish species or life stages. However, it is assumed that such adverse effects would be assessed through the adaptive management process, which could result in changes to the conservation measures to minimize these effects. To minimize the potential for entrainment of fish at the new diversion facilities on the Sacramento River, state-of-the-art positive-barrier fish screens will be constructed at each of the new intakes and flexible operational methods related to the timing and rate of diversion will be coordinated among the intake facilities. The positive barrier fish screens will be designed and operated in accordance with design criteria (e.g., screen mesh size, approach velocity) currently used by the California Department of Fish and Game (DFG), NMFS, and USFWS. These operational measures have been devised to ensure that potential risks to migrating juvenile salmonids and other species (e.g., delta smelt) from the operation of the new north diversion facility will be avoided or otherwise minimized.

The water operations conservation measures establish criteria for water diversion rates and bypass flows in the Sacramento River at the diversions that reflect seasonal movement patterns of covered fish species, including specific responses during periods in which fish species are present in the vicinity of the diversions. These criteria have been developed to better reflect seasonal synchrony with hydrologic conditions within the river and upstream watersheds. Bypass criteria set out in *CM1 Water Facilities and Operation* reflect the variation in the seasonal periods of hydrology. The criteria include pulse flow operations, minimum river flow requirements, and flow requirements based on a percentage of the river flow that would pass by the diversions (bypass flows). Extensive hydrologic simulation modeling has been used to evaluate and develop the range of water diversion criteria included in the conservation strategy.

Proposed water operations conservation measures include actions to improve flows through the Yolo Bypass floodplain, ensure sufficient water for fish transport in the Sacramento River downstream of the north Delta intakes, deter fish from being drawn into the central Delta through the Delta Cross Channel via nonphysical fish barriers, provide quality habitat for delta smelt and longfin smelt in the Delta and Suisun Bay, and minimize entrainment of fish at the south Delta SWP/CVP diversions. The flexibility associated with the operation of dual facilities in the north and

south Delta will allow for physical habitat restoration in the western, eastern, and southern Delta. Some of the enhanced production of carbon, zooplankton, and phytoplankton generated from these restored habitats is expected to pass through the interior Delta, while some should also be consumed by fish within and adjacent to the marshes. The flexibility of dual conveyance will also allow substantial reductions in fish entrainment at the south Delta facilities while meeting the overall BDCP goal, which is to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework.

The conservation measures also include modification of Fremont Weir (lowering a portion of the weir and installing an operable gate facility) and changes to its operation to improve the inundation regime in the Yolo Bypass. Research suggests that covered fish species, particularly splittail and Chinook salmon, would benefit significantly from optimizing the frequency, duration, and timing of seasonal inundation of the Yolo Bypass floodplain habitat (Sommer et al. 1997, 2001a, 2001b, 2004a, 2004b). In addition, conservation measures are also designed to increase levels of phytoplankton, zooplankton, and other organic material transported from the Yolo Bypass floodplain to Cache Slough, the lower Sacramento River, the western Delta, and Suisun Bay, which will increase the food supply for delta smelt and longfin smelt in those areas.

Operational criteria presented in *CM1 Water Facilities and Operation* set seasonal limits on Old and Middle River reverse flows. To reduce the risk that south Delta SWP and CVP exports cause direct losses or salvage of covered fish species, or increases in the export of nutrients and food resources produced in restored southern and eastern Delta marshes, *CM1 Water Facilities and Operation* provides for seasonally adjusted year-round limits on Old and Middle River reverse flows.

The western Delta and Suisun Bay system functions as an estuarine mixing zone for freshwater passing downstream from the tributary rivers and saltwater intrusion from coastal waters through San Francisco Bay. Suisun Bay and the western Delta serve as the low salinity mixing area that has been found to be important rearing and foraging habitat for the covered fish species. This estuarine habitat is also important to production of phytoplankton, zooplankton, and many other aquatic organisms that are prey of covered fish species. The dynamics of the estuarine zone are determined largely by tides and the balance between Delta inflow and Delta outflow. Habitat conditions and salinity gradients in the Suisun Bay and western Delta are most important to covered fish species during the winter and spring months. Consequently, *CM 1 Water Facilities and Operation* includes seasonally adjusted Delta flow regimes designed to better maintain the functions of the estuarine habitat, and thus provide improved conditions for the covered fish species.

3.2.3.2 Physical Habitat Restoration

A second major component of the conservation strategy for aquatic resources is the protection, enhancement, and restoration of habitats and natural communities that support covered species. Habitat enhancement and restoration actions will involve both the re-establishment of habitat in locations that historically supported such habitat and the creation of habitat on altered landscapes where no such habitat previously existed. Habitat enhancement refers to the improvement of ecological functions of existing habitat; habitat protection refers to the preservation of existing habitat susceptible to changes in use by human activity.

The habitat restoration conservation measures include commitments to restore natural habitats at a substantial scale. These actions will restore natural habitat mosaics and gradients to levels that have not been present in the Delta for at least 70 years. Specifically, these conservation measures will

restore 65,000 acres of natural communities, including tidal wetland and associated estuarine and upland habitats distributed across the Delta, but primarily located within Suisun Marsh and the north Delta Cache Slough complex. ROAs have been identified within the Delta and Suisun Marsh that are characterized by physical habitat conditions suitable for tidal marsh restoration (Figure 3.2-2). The ROAs encompass potential restoration areas that could support covered fish species that use main channels, distributaries, and sloughs of the Sacramento, San Joaquin, and Mokelumne Rivers in the Delta and the channels and sloughs of Suisun Marsh. Within the floodplain and tidal restoration areas, at least 5,000 acres of riparian habitat restoration will be implemented. These conservation actions will restore large tracts of Delta tidal marsh, estuarine, and seasonal floodplain habitats of sufficient size and connectivity to substantially increase the extent of physical habitat for covered species (including cover, rearing habitat, nesting habitat, and food resources) and improve overall food web productivity in the restoration areas and adjacent aquatic habitat.

3.2.3.3 Measures to Address Other Stressors

The conservation strategy for aquatic resources provides measures to reduce the direct and indirect adverse effects of other stressors on the ecological functions of the Delta and on covered fish species and natural communities. These other stressors include, among other factors, nonnative predators, localized low dissolved oxygen, and genetic issues associated with hatchery fish.

Specific conservation measures to address these other stressors include actions to reduce predator levels through removal of predator habitat, such as submerged and floating aquatic vegetation and abandoned structures and vessels, particularly in reaches important to juvenile salmonid migration. New nonphysical barriers are proposed to direct certain covered species away from areas that pose a high risk of predation and entrainment. Other measures include actions to increase dissolved oxygen in specific problem areas important to salmonid migration, and to develop new and expanded conservation hatcheries for delta smelt and longfin smelt for the purpose of establishing refugial populations.

3.2.4 Developing the Terrestrial Resources Component of the Conservation Strategy

The conservation strategy for terrestrial resources comprises a comprehensive program that protects existing functioning natural communities, restores new areas of specific natural communities, enhances the function of degraded natural communities for covered species habitat, establishes long-term management of geographically distributed conservation lands, and provides monitoring and adaptive management actions to measure and ensure success of the conservation strategy. The conservation strategy reflects well-established principles of conservation biology. The approach is designed to maximize opportunities to protect and restore natural communities sufficient to achieve the goals and objectives for the covered terrestrial species. The natural community measures include specific targets for habitat protection and restoration, including requirements relating to preserve size, habitat corridors and linkages, and preserve management. Where the goals and objectives for a covered terrestrial species may not be fully achieved through implementation of the natural community conservation measures, species-specific conservation measures have been included to ensure the species needs are being met.

Because of the diverse species habitat requirements and highly altered nature of the Delta, the covered wildlife and plant species are distributed unevenly in the Plan Area, often in discrete, disconnected patches of habitat. A few of the covered wildlife and plant species are distributed broadly across the Plan Area, but many of the covered wildlife and plant species are found only at the margins of the Plan Area or in discrete portions of the Plan Area. For some of these species, the Plan Area only provides low-quality or marginal habitat, while for others the Plan Area provides the key resources required for conservation. Hence, the conservation approaches vary for the covered wildlife and plant species because of the large variation in the importance and quality of habitat conditions within the Plan Area for these species.

Each natural community supports habitat for multiple covered wildlife and plant species, and the suite of species' habitats supported by some communities are similar. Conservation of each natural community is addressed based on the specific spatial, temporal and structural attributes of those communities in relation to the needs of the covered wildlife and plant species.

The conservation strategy includes measures to provide connectivity between areas that are important for sustaining and improving ecosystem functions and providing for the conservation of covered species. For some species and natural communities this increased connectivity will be achieved through large-scale restoration of aquatic communities, such as tidal habitats concentrated in the Delta and Suisun Marsh and associated riparian forest and scrub. For covered species that occur in terrestrial natural communities along the periphery of the Plan Area (e.g., San Joaquin kit fox, California red-legged frog), opportunities for increased habitat connectivity will be mostly between existing and newly protected terrestrial habitat in the Plan Area and protected terrestrial habitat adjacent to the Plan Area (mostly associated with adjacent or surrounding HCPs and NCCPs).

The geographic pattern of habitat protection and restoration in the Plan Area will result in a system of core habitat patches linked by ribbons of habitat along channels, sloughs, and floodplains. This approach can be thought of as a "node and network" approach. In habitat areas that covered species currently occupy, patches or "nodes" of protected and restored habitat will be established to address site-specific species needs. The Plan provides for large-scale protection and restoration of habitat along the channels, floodplains, and sloughs of the Delta and Suisun Marsh that will provide a network of habitat connections between nodes of protected and restored core habitats. Steps to establish a connectivity network for covered species within the Plan Area will be informed and guided by the California Essential Habitat Connectivity project (Spencer et al. 2010).

Many of the natural communities addressed by the BDCP share common characteristics that are related to spatial proximity on the landscape, shared ecosystem process (e.g., exchanges of nutrients through daily tidal cycles or seasonal flooding regimes), and similarity of habitat structural characteristics (e.g., herbaceous versus woody vegetation), and some are dominated by human land use practices (e.g., managed wetlands or cultivated lands). For example, tidal freshwater emergent wetland, tidal mudflat, and tidal perennial aquatic natural communities are typically spatially contiguous along a tidal elevation gradient and are linked through ecosystem processes such as energy and nutrient flows. Another example is the spatial distribution of grassland, alkali seasonal wetland complex, and vernal pool complex communities that, within the Plan Area, are typically intermingled with each other to the extent that they form a complex mosaic on the landscape. While grassland in the Plan Area can occur in discrete patches that can be mapped, it is often intermixed with the alkali seasonal wetland and vernal pool complexes. On fine spatial scales, the seasonal

wetland communities are embedded as "islands" within a larger matrix of the grassland natural community; for BDCP development, those areas were mapped as complexes of communities.

3.2.4.1 Conservation Targets

Conservation targets have been established for the natural communities and the covered wildlife and plant species habitats they support. Conservation targets represent the extent and distribution of habitat to be protected, enhanced, and restored/created to achieve the biological goals and objectives. Under the monitoring program, the effectiveness of habitat protection, enhancement, restoration, and management actions will be assessed and potential adjustments to conservation actions can be identified to maintain or improve habitat functions over time (Section 3.6, *Adaptive Management and Monitoring Program*). The habitat conservation targets are intended to satisfy mitigation requirements associated with the effects of covered activities on covered species and provide for the conservation of those species and their habitats.

The process used to develop conservation targets for natural communities and the covered wildlife and plant species is presented in Figure 3.2-13. The information used to develop the conservation targets included the following elements.

- Current distribution and extent of each natural community within the Plan Area (Figure 3.2-3 through Figure 3.2-12).
- Distribution and extent of each covered species' modeled habitat located within the Plan Area (Figure 3.3-1 through Figure 3.3-60 in Section 3.3.5, *Species Biological Goals and Objectives*).
- Primary threats and stressors for each of the covered species (Appendix 2.A, *Covered Species Accounts*).
- Location of habitat areas known to be occupied by each of the covered species (Appendix 2.A, *Covered Species Accounts*).
- The distribution and extent of existing protected patches of each natural community and covered species habitat (Figure 3.2-3 through Figure 3.2-12 and Figure 3.3-1 through Figure 3.3-60, respectively).
- Potential for increasing connectivity with conserved habitat areas adjacent to the Plan Area (from documents of HCP/NCCPs approved or under development for lands adjacent to the Plan Area).

To establish the conservation targets, this information was evaluated for each of the following variables.

- Patch size and connectivity of each natural community with other protected and unprotected natural community patches, and connectivity with existing protected natural communities. The conservation targets were formulated to include large patches of connected natural communities rather than small fragmented/disconnected patches.
- The extent of modeled habitat for covered species that is supported by each natural community within each of the conservation zones. The conservation targets were formulated to include natural communities in locations that support modeled habitat for multiple covered species and exclude areas that do not support modeled habitat for covered species or only a relatively small

number of covered species, except where such patches are important for conserving a particular species or providing connectivity between larger natural community patches.

- The habitat value of patches of natural communities to covered species and the ability to maintain such habitats into the future. The conservation targets minimize protecting low value habitats (e.g., disconnected or fragmented patches of grassland on levee slopes) and habitat areas at risk for future loss to natural events (e.g., habitats on subsided lands that may be lost to future levee failures associated with flood and seismic events).
- The patch size and connectivity of each covered species' modeled habitat to other patches of modeled protected and unprotected species habitat within the Plan Area and habitat adjacent to the Plan Area. The conservation targets were formulated to prioritize large patches of connected modeled habitat for each of the covered species rather than small fragmented patches, except where small patches may provide connectivity between larger patches.
- Location of important known covered wildlife species population centers and covered plant species occurrences. The conservation targets were formulated to protect a proportion of these habitat areas such that these populations and occurrences will be conserved.
- Proximity of modeled covered species habitats to known occupied habitats. The conservation targets were formulated to prioritize the protection of occupied habitats as well as currently unoccupied habitat areas connected to known occupied habitat areas such that, with implementation of conservation measures, unoccupied habitat areas may become occupied in the future.

Based on the evaluation of these variables for each natural community and covered wildlife and plant species, the conservation targets were established such that, once they are achieved, the largest and most significant patches of natural communities and associated covered species habitats remaining in the Plan Area will be protected. The rationale for how the natural community conservation targets address the conservation needs for each of the covered species is presented in Section 3.3.5, *Species Biological Goals and Objectives*.

Actions that provide for the conservation of the covered species and their habitats include habitat protection, enhancement, restoration, and management. Conservation actions also include targeted species-specific actions, some of which reflect approaches identified in approved recovery plans and approved conservation plans that overlap with the Plan Area.

3.2.4.2 Assembly of Conservation Lands

Conservation lands include all areas of land and water in BDCP protected, restored, and created natural communities in the Plan Area at full BDCP implementation. Upon full assembly of conservation lands over the term of BDCP implementation coupled with the continued operations of water facilities and management of habitats and other stressors conservation actions, all natural community and species-specific goals and objectives are expected to be achieved. This section provides a discussion of the considerations associated with the assembly of conservation lands and guidance for selecting lands for conservation during implementation of the BDCP. Included are discussions of conservation land assembly principles, existing protected lands and their relationship to conservation land assembly, conservation actions that may occur outside the Plan Area, and the relationship between other regional conservation planning programs and the BDCP conservation strategy.

3.2.4.2.1 Conservation Land Assembly Principles

The following conservation land assembly principles describe considerations used to distribute the conservation of natural communities and covered species habitats among the conservation zones to ensure the greatest biological benefits. These assembly principles provide guidance to the BDCP Implementation Office for selecting conservation lands.

- Protect, enhance, and restore the ecological diversity of natural communities and covered species habitats at the periphery of the Plan Area on lands most likely to accommodate future sea level rise and less likely to be flooded as a result of levee failures (i.e., terrestrial habitat conservation areas should be located where there is a low risk of future flooding).
- Maintain a range of contiguous ecological gradients and provide connectivity between estuarine/wetland and upland communities inside and outside the Plan Area.
- Design reserves to appropriately scale the ecological gradient and emphasize compatibility between restored natural communities and working landscapes (e.g., agricultural lands).
- Design reserves of sufficient size to ensure the intended conservation benefits for the target covered species.
- Design reserves of sufficient size and configuration to ensure that they can be effectively managed given site constraints.
- Maximize connections between preserve lands within and outside of the Plan Area.
- Where possible, build onto existing preserves and management systems to increase management efficiency, connectivity and patch size.
- Protect the highest quality natural communities and covered species' habitats available consistent with the BDCP implementation schedule.

The following concepts will be used by the BDCP Implementation Office to guide the design and timing of restoration actions and selection of sites for habitat protection and restoration.

- During the BDCP near-term implementation period, focus restoration and enhancement of covered fish species habitats in north Delta locations to generate improvements in productivity consistent with continued operations of the south Delta SWP/CVP facilities.
- Identify restoration areas and design actions to accommodate and integrate with *CM1 Water Facilities and Operation* to optimize primary and secondary productivity, spawning and rearing, and other aquatic functions that support covered species (i.e., allochthonous inputs, complex habitat, floodplain connectivity, more natural flow regimes).
- During the BDCP long-term implementation period, expand the restoration and enhancement of covered fish species habitats to include the Mokelumne and San Joaquin River deltas to provide benefits to covered fish species found in each of those areas.
- Implement conservation measures for terrestrial and nontidal wetland communities and covered wildlife and plants in a manner that complements the conservation strategies of approved and developing conservation plans for areas adjacent to and overlapping the Plan Area.
- Restore habitat in large patches to increase the likelihood of providing the desired levels of ecological function and to support large numbers of covered species.

- Strategically distribute restored and enhanced habitats throughout the Delta to minimize the risk of loss of habitat benefits to catastrophic events in one part of the Delta, while maintaining the goals of large, connected preserve systems.
- Distribute and design restored habitats to withstand potential changes in Delta conditions associated with future sea level rise and changes in stream hydrographs.
- Design tidal habitats to withstand effects associated with Delta levee failures.
- Restore suitable habitat in patch sizes that are equal to or greater than the patch sizes required to meet the ecological needs of the covered species, considering adjacent and connected habitats as appropriate.
- Juxtapose restored habitats with existing habitats to improve and maintain habitat corridors and connectivity among covered species habitats.
- Locate and design restored habitats to provide beneficial hydrodynamic effects on adjacent channel systems (e.g., increased tidal flows that may result in decreased bidirectional flow in upstream channels or provide greater mixing in adjacent channels).
- Locate and design restored habitats to create natural gradients in the Delta that historically transitioned from shallow subtidal aquatic habitats, to riverine floodplain habitats, and to transitional upland habitats (seasonal wetland, riparian, grassland).
- Design tidal marsh and seasonally inundated floodplain habitats to provide ingress and egress for covered fish species in a manner that avoids stranding or trapping of fish.
- Locate and design restored habitats to minimize potential effects of other stressors that could degrade intended covered species benefits (e.g., effects of nearby diversions, discharges of low-quality water).

3.2.4.2.2 Existing Protected Lands

An important consideration in the assembly of BDCP conservation lands is the extent and distribution of existing protected lands that conserve natural communities and covered species habitats. The BDCP Protected Lands geographic information system (GIS) dataset identifies existing protected lands within the Plan Area. The BDCP Protected Lands GIS data layer was generated using these public dataset sources, which were used to create Figure 3.2-14.

- DFG Lands GIS data layer 2010
- California Protected Areas Database March 2009
- Central Valley Farmland Trust 2009
- Yolo County Assessors Data 2009
- Yolo County Natural Heritage Program 2009
- Delta Parcels data created by DWR for SAIC 2008
- Delta Wetlands Program website 2008
- DWR ownership layer created for SAIC 2008
- Sacramento Bee 2008

- Wildlife Conservation Board 2008
- GreenInfo 2007
- Solano County Water Agency 2007
- CaSIL Conservation Lands data layer 2005
- USGS Oil & Gas Assessment Program 2003
- CA Public, Conservation and Trust Lands, v5.2

Ownership information was collected and organized by County, County Assessor's Parcel Number, Management Level, Management Agency, Alias (if known), Type (type of ownership), and Data Source attributes. Although the boundaries depicted within the data do not represent legal boundaries, they represent the best available information and were considered to be sufficiently accurate to guide development of the conservation measures for the system of conservation lands at a landscape level.

The data layer was created by overlaying source data on top of county parcel boundary data. Parcels identified as protected lands via source datasets were then attributed with the appropriate information.

Based on the ownership information derived from the aforementioned sources, protected lands were grouped into three primary categories.

- **Category 1.** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority and with a primary management goal related to protection of ecological value.
- **Category 2.** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority with a primary land management goal assessed to be that of open space for mixed use in a manner that maintains ecological value.
- **Category 3.** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority. However, these lands are not managed primarily for ecological protection nor are they managed as open space for mixed use in a way that maintains ecological value.

Properties excluded from consideration included those owned by the U.S. Department of Defense and city parks. Figure 3.2-15 illustrates a decision matrix that was applied to assign protection categories.

The distribution of existing protected lands by conservation zone is presented in Figure 3.2-16. The extent of each natural community and the extent of covered species habitat in each of the conservation zones is presented in Appendix 3.D, *Natural Community and Covered Species Habitat Existing Condition*.

3.2.4.2.3 Relationship between other Regional Conservation Planning Programs and the BDCP Conservation Strategy

Several regional conservation plans have been approved in the vicinity of the Delta and others are being developed. These plans are generally sponsored by local governments and special districts to

address the mitigation and conservation needs of terrestrial and wetland wildlife and plant species. The regional conservation plans that overlap with the BDCP, listed in rank order of amount of physical overlap, are listed below and illustrated in Figure 1-2.

- San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (approved)
- East Contra Costa County HCP/NCCP (approved)
- Solano HCP (in development)
- Yolo Yolo Natural Heritage Program (in development)
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan (in development)
- South Sacramento HCP (in development)
- East Alameda County Conservation Strategy (approved)

The San Joaquin County HCP has the largest amount of overlap with the BDCP Plan Area with more than 300,000 acres of land in common. The East Alameda County Conservation Strategy has the least amount of overlap with the BDCP Plan Area with less than 5,000 acres of land in common. An additional plan, the approved Natomas Basin HCP in Sacramento and Sutter Counties, is adjacent to the Upper Yolo Bypass area that is included in the BDCP conservation strategy. Most of the BDCP wildlife and plant covered species are also covered or proposed for coverage by at least one of these other plans (Table 1-3). The geographic and species overlap with surrounding plans provides an opportunity for collaboration and partnership in the implementation of conservation actions common to these plans and the BDCP. For more description of these plans, see Section 1.5, *Relationship to Other Plans in the Delta*.

Opportunities exist for joint implementation of conservation actions for covered species and natural communities both inside and outside of the BDCP Plan Area. The BDCP Implementation Office may partner with willing regional conservation planning sponsors to jointly implement conservation actions that complement each plan and provide economies of scale and efficiencies. These partnerships would be guided by the following criteria.

- The BDCP is responsible for the mitigation of its effects.
- The mitigation actions and the mitigation requirements of the BDCP must be additive to the mitigation obligations of other plans (i.e., BDCP mitigation cannot supplant the mitigation obligations of other plans and vice-versa).
- In cases where BDCP shares a conservation requirement with another conservation program that is unrelated to mitigation for either program (i.e., the actions are for contribution to recovery) and there are limited opportunities for both plans to achieve that requirement separately, BDCP and the other conservation program may share conservation credit for the same action with fish and wildlife agency approval. (This situation is most likely to arise for requirements to protect rare and fragmented natural communities.)
- Conservation actions implemented by another conservation program within the BDCP Plan Area on behalf of the BDCP could be funded by the BDCP to cover the costs of initial implementation, long-term management, long-term monitoring, and remedial actions.

3.2.5 References

Anderson, J., R. Kneib, D. Reed, and K. Rose. 2011. Bay-Delta Conservation Plan science advisors draft report on BDCP goals and objectives for covered fish species. 58pp. Available at: http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/6-16-11_Draft_Final_BDCP_G_O_Science_Advisors_Report.sflb.ashx

Baxter, R. D., R. Breuer, L. R. Brown, L. Conrad, F. Freyer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Müller-Solger, T. Sommer, and K. Souza. 2010. Interagency Ecological Program 2010 Pelagic Organism Decline Work Plan and Synthesis of Results: Interagency Ecological Program for the San Francisco Estuary. Sacramento, CA.

CALFED Bay-Delta Program. 2008. The State of Bay-Delta Science. Available: <http://science.calwater.ca.gov/publications/sbds.html>. Accessed: November 17. 2011.

Dahm, C., D. Reed, E Soderstrom, and J. Wiens. 2010. Bay-Delta Conservation Plan Delta Science Program Panel Review of the Logic Chain Approach. Prepared for the BDCP Steering Committee. 14pp.

Essex Partnership. 2009. DRERIP Evaluations of BDCP Draft Conservation Measures. Summary Report. Available: <http://science.calwater.ca.gov/pdf/workshops/workshop_eco_052209_BDCP-DRERIP_Summary_with_Appendices1.pdf>. Accessed: December 9, 2011.

Glibert, P.M., 2010. Long-term Changes in Nutrient Loading and Stoichiometry and their Relationships with Changes in the Food Web and Dominant Pelagic Fish Species in the San Francisco Estuary, California. By Patricia M. Glibert, University of Maryland Center for Environmental Science, Horn Point Laboratory, PO Box 775; Cambridge, MD 21613 USA.

Lund, J., E. Hanak, W. Fleenor, R. Howitt, J. Mount, P. Moyle 2008. Comparing Futures for the Sacramento-San Joaquin Delta.

Lund, J., E. Hanak, W. Fleenor, R. Howitt, J. Mount, P. Moyle. Envisioning Futures for the Sacramento-San Joaquin Delta.

National Marine Fisheries Service. 2004. Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan

National Marine Fisheries Service. 2009. Conference Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan

National Research Council of National Academies. 2011. Panel to Review California's Draft Bay Delta Conservation Plan. Water Science and Technology Board, Ocean Studies Board, Division on Earth and Life Studies. The National Academies Press, Washington, D.C.

Sommer, T., R. Baxter, and B. Herbold. 1997. Resilience of splittail in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society. 126:961-976.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, W. Kimmerer, and L. Schemel. 2001a. California's Yolo Bypass: evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. Fisheries. 26(8): 6-16.

Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001b. Floodplain rearing of juvenile Chinook salmon: Evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences. 58(2): 325-333.

Sommer T.R., W.C. Harrell, R. Kurth, F. Feyrer, S.C. Zeug, and G. O'Leary. 2004a. Ecological patterns of early life stages of fishes in a river-floodplain of the San Francisco Estuary. *In:* F Feyrer, LR Brown, RL Brown, JJ Orsi, eds. Early Life History of Fishes in the San Francisco Estuary and Watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland. Pages 111-123.

Sommer, T. R., W. C. Harrell, A. Mueller-Solger, B. Tom and W. J. Kimmerer. 2004b. Effects of flow variation on channel and floodplain biota and habitats of the Sacramento River, California, USA. Aquatic Conservation: Marine and Freshwater Ecosystems 14: 247-261.

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

Thompson, B., R. Hoenicke, J. A. Davis, and A. Gunther. 2000. An overview of contaminant related issues identified by monitoring in San Francisco Bay. Environmental Monitoring and Assessment 64:409-419.

U.S. Fish and Wildlife Service. 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP).

Williams, D.D. 2006. The biology of temporary waters. Oxford University Press, New York.

Williams, R. N., P. A. Bisson, D. Bottom, L. D. Calvin, C. C. Coutant, M. W. Erho, C. A. Frissell, J. A. Lichatowich, W. J. Liss, W. E. McConnaha, P. R. Mundy, J. A. Stanford, and R. R. Whitney. 1999. Scientific issues in the restoration of salmonid fishes in the Columbia River. Fisheries 24(3):10-19.

GIS data sources [*citations unresolved*]:

CA Public, Conservation and Trust Lands, v5.2
California Protected Areas Database March 2009
CaSIL Conservation Lands data layer 2005
Central Valley Farmland Trust 2009
Delta Parcels data created by DWR for SAIC 2008
Delta Wetlands Program website 2008
DFG Lands GIS data layer 2010
DWR ownership layer created for SAIC 2008
GreenInfo 2007
Sacramento Bee 2008
Solano County Water Agency 2007
USGS Oil & Gas Assessment Program 2003
Wildlife Conservation Board 2008
Yolo County Assessors Data 2009
Yolo County Natural Heritage Program 2009